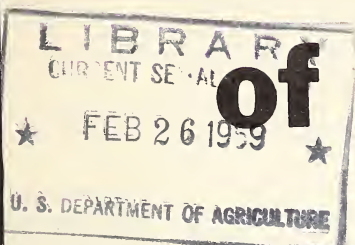


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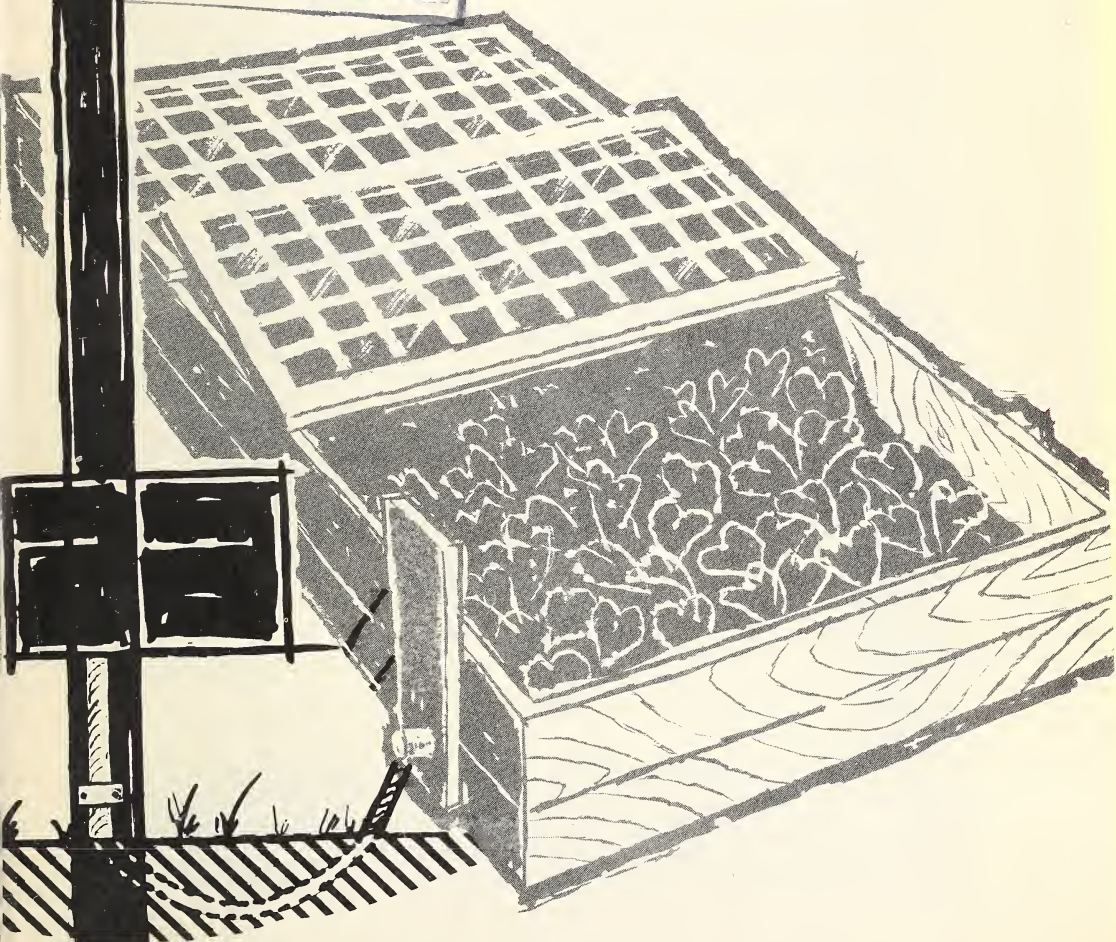
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Electric heating of HOTBEDS



Leaflet No. 445



U. S. DEPARTMENT OF AGRICULTURE

Electric heating of HOTBEDS

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Electrically heated hotbeds are well suited for growing vegetable plants that are transplanted later to field or coldframe.

Such beds offer several advantages over manure- or fuel-heated beds. Less labor is required to operate the bed. More uniform and more positive control of temperature in the bed is possible. Therefore, more uniform plants of the desired quality usually can be produced.

An electrically heated bed may be more economical in the long run, provided it is properly built and electricity is available at reasonable cost.

BUILDING THE BED

Location

A good location is essential for satisfactory operation of the bed.

Select an area where the soil has good natural drainage that prevents excess moisture just beneath the hotbed. It should be close to a source of electricity and water. Buildings or other objects should not block sunlight from the bed.

The bed should have a southern exposure so that it receives the maximum amount of sunlight. If the area selected is on sloping land, a southern slope is preferable. Some form of windbreak on the north or windward side will help to reduce operating costs. A building makes an excellent windbreak, but it should not block the sunlight.

Size

Almost any size hotbed can be electrically heated. Beds 12 feet wide have been operated success-

fully, but a narrower bed is easier to work.

The size of the bed will depend on your planting requirements—kind of plants, number of plants, and spacing between plants and plant rows.

Table 1 contains information on planting various crops in a 6-by-3-foot bed.

A standard glass sash is 6 by 3 feet. If you plan to use this type of covering, a practical width for a bed is 5 feet 8 inches. The length would be a multiple of 3, such as 6, 9, 12, or 15 feet.

In determining the size of the bed, you should consider also the length of cable to be used (see p. 4).

TABLE 1.—Seed required and plant capacity, 6- by 3-foot hotbed

Plant	Amount of seed	Number of seedling plants ¹
Tomato-----	<i>Ounce</i> ½ to ¾	2,000 to 3,000.
Sweetpotato-----	<i>Bushels</i> 1½ to 2	3,000 to 4,000.
Cabbage-----	<i>Ounces</i> ¾	3,750.
Pepper-----	1½	2,000 to 2,500.
Eggplant-----	1½	3,000 to 4,000.
Lettuce-----	¼ to ½	2,500 to 4,000.

¹ When the plants are transplanted to coldframes, allow a minimum of 4 square inches per plant. If the bed is used as a coldframe, the plants should be thinned to the same spacing. The bed will then accommodate about 600 plants. Sweetpotatoes are not transplanted to coldframes. They are transplanted directly to the field.

Materials

Most beds are constructed with wood sidewalls. When electricity is used for heating, permanent-type beds are sometimes preferred. Concrete poured in place or masonry blocks are the best materials to use for the walls of a permanent bed. When properly constructed, the walls last longer and require less maintenance than wood walls. Concrete or masonry-block walls 6 inches thick will suffice if they are properly reinforced and supported on adequate footing. Use good mortar in laying masonry blocks. Poor joints permit air leakage and increase operating costs and maintenance.

If the walls are made of wood, use tongue-and-grooved dressed lumber 2 inches thick. If that type is not available, use 2-inch lumber, dressed on all sides, with weatherstripping on joints. Treat the wood with copper naphthenate or some other product that retards decay but will not injure the

plants. *Do not use creosote; it is harmful to plants.*

Ground Work

The bed area must be level. If sloping land is leveled, be sure that runoff water will not enter or stand around the bed.

It may be necessary to place cinders or gravel under the bed to insure proper drainage. Excavate the bed area to a depth of about 8 inches. After the walls are built, tamp cinders or gravel to a depth of 6 inches in the excavated space. Cover the cinders or gravel with burlap or some other material that will permit water to pass through yet prevent sand from sifting down.

Add a 2-inch layer of sand. The sand is important. It protects the heating cable, which is laid on it, from mechanical or chemical damage. Sharp stones may cut insulation or lead covering on heating cable. Cinders react chemically with the lead covering of cables and cause trouble.



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Electrically heated hotbed. The fence serves as a windbreak.

Construction

Build the back, or north, wall 18 inches above the level at which the heating cable is placed. Side walls usually slope toward the front about 1 inch per foot of width. If the bed is 6 feet wide, the front wall will be 12 inches high. This will provide 6 inches of space between the soil and the sash along the front edge, which is ample room for plants.

If the bed area was excavated, extend the walls down to the bottom of the excavation. If the area was not excavated, extend the walls down to about 4 inches below the level at which the heating cable is placed.

The footing for concrete or masonry-block walls must be placed below the frostline. Otherwise, when the bed is not in use, trouble is likely to occur from freezing and thawing. The walls must be deep enough to prevent damage from freezing. The slope on the side walls is obtained by pouring concrete to the desired slope. With masonry-block walls, this is done by clamping forms to the walls after they are in place. Use a relatively dry concrete mixture.

Nail 1-by-4-inch boards to the outside top edge of the back and side walls. (The sashes extend over the edge of the front wall to shed water.) The boards serve as weatherstripping and reduce heat loss between walls and sashes. Bank soil against the outside of the walls to prevent air leakage.

Covering

Glass sash is the best type of covering for hotbeds, but it is also the most expensive. Other material, such as plastic film, plastic-coated fabric, or treated muslin, provides satisfactory covering in warmer climates and reduces construction costs.

Use removable sash supports between sashes. A 1-by-4-inch board, with a 1-by-2-inch board fastened on edge to its center, makes a good sash support, and also serves as weatherstripping.

HEATING CABLE

Selection

Various types of electric heating cable are available. Both lead-covered and plastic-covered give satisfactory results when used properly.

In selecting cable you must know how many watts per square foot of bed area are needed to provide adequate heat. In southern areas, 10 watts per square foot have proved adequate. In northern areas, where extremely low temperatures are anticipated during the period the bed will be used, as much as 16 watts per square foot may be needed.

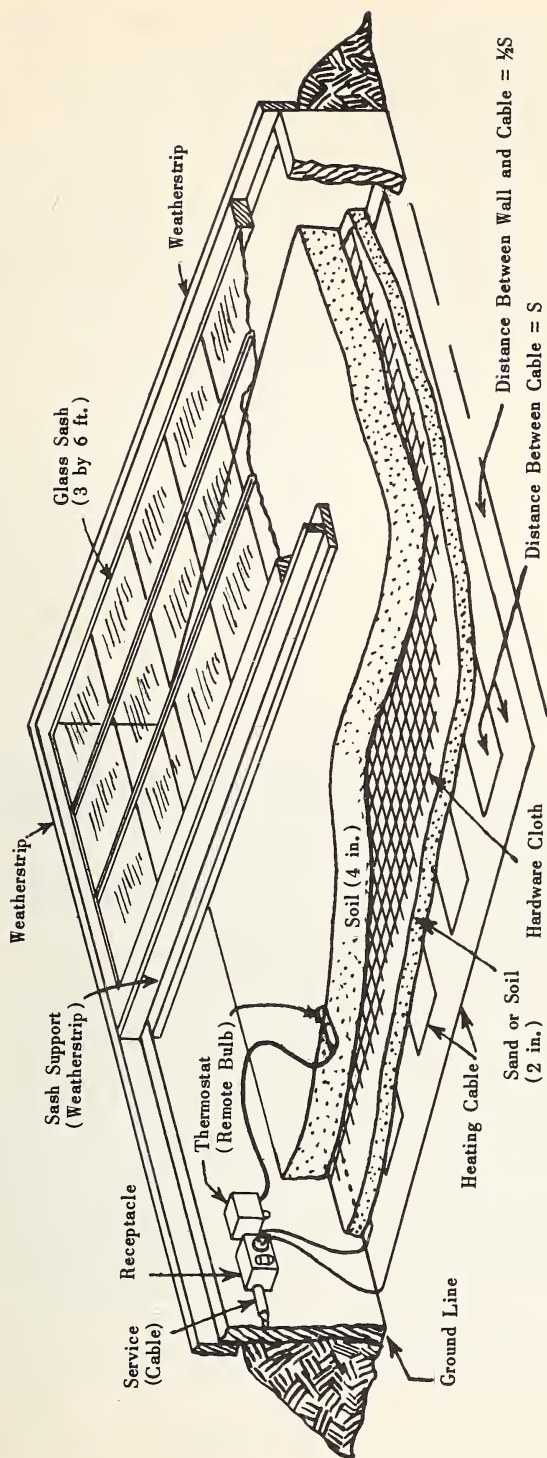
The cables vary in length and wattage rating (heating capacity). Some are 60 feet long and are rated at 400 watts, or 6.7 watts per foot. Others are 120 feet long and are rated at 800 watts, also 6.7 watts per foot. Some are 60 feet long and are rated at 300 watts, or 5 watts per foot. Various other combinations in length and wattage rating are available.

Your power supplier or a qualified dealer can assist you in selecting heating cable.

Laying the Cable

Lay the cable on the soil at the bottom of the bed. Or, if the bed was excavated, lay it on the sand that was spread on the cinders or gravel.

NOTE.—In at least one section of the country, the practice is to embed the cable in concrete. Further information is available from your State Extension Agricultural Engineer.



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Construction of an electrically heated hotbed.

The spacing between loops or sections of cable is important; it governs the number of watts per square foot of soil area. Uniform spacing is the method most commonly used. Determine the proper spacing as follows:

$$\text{Spacing (in inches)} = \frac{12 \times \text{watts per foot of cable}}{\text{Wattage required per square foot of bed}}$$

Example: You have a 120-foot cable rated at 800 watts. You wish to supply 10 watts per square foot.

$$\begin{aligned} \text{Spacing} &= \frac{12 \times (800 \div 120)}{10} \\ &= \frac{12 \times 6.7}{10} \\ &= \frac{80.4}{10} \\ &= 8 \text{ inches} \end{aligned}$$

The spacing between the outside cable and the wall is half the spacing between cables (or 4 inches in the example given).

After the cable is in position, cover it with a 2-inch layer of loose soil or sand. Then place a 1/2-inch-mesh hardware cloth on top of the soil or sand. The hardware cloth prevents possible damage to the cable when sharp instruments are used in working the bed.

Precautions

Observe these precautions when placing the cable:

Lay the cable in position carefully to avoid damaging the sheath or conductor. Kinks may damage or break the cable.

Do not cross one cable or section of cable over another.

Do not shorten the length of a cable. A shortened cable may become too hot and burn out.

ELECTRIC WIRING

The bed must be properly wired to operate satisfactorily. The wiring should conform to the National Electrical Code and to the requirements of the local power supplier. It should be installed or checked by a representative of the power supplier or a qualified electrician.

Small beds—3 sashes or less—can be operated satisfactorily on a 120-volt electric system. Beds of 4 or more sashes should be operated on a 240-volt system.

Heating cables are designed to operate on either 120 or 240 volts. Always connect a cable to a power supply of the specified voltage.

Install a weatherproof service switch, properly fused and grounded, on a pole adjacent to the bed. The wiring from the electricity source to the switch must be large enough for the distance and heating load. Connect a service cable from the switch to the heating-cable. *Make all connections to the heating cable watertight to exclude moisture.*

THERMOSTAT

Installation

Connect a thermostat with an operating range of about 30° to 120° F. in the electric circuit to control the temperature in the bed. It can be a type that can be buried in the soil or one that has a remote-temperature bulb for that purpose. The type with a remote-temperature bulb is recommended for large beds. Thermostats that are buried in the soil work satisfactorily in small beds.

The thermostat must have sufficient current-carrying capacity to handle the electric load of the bed or section of bed that it controls. Large beds require a ther-

mostat for each section in which a different temperature is maintained, or for each electric circuit serving a cable or group of cables. Your power supplier's representative or an electrician can help you determine the size of thermostat required.

Place the temperature-sensing element (the thermostat or the remote-temperature bulb) one-third of the way across the width of the bed and at the same distance from the end wall. Some growers bury it about 1 inch in the soil. Others set it in a vertical position with the bottom half buried. In the latter position, it is affected by both soil and air temperatures. Do not place the thermostat or bulb directly above a heating cable or allow it to come in contact with a cable. For sweetpotatoes, place it among the seed potatoes.

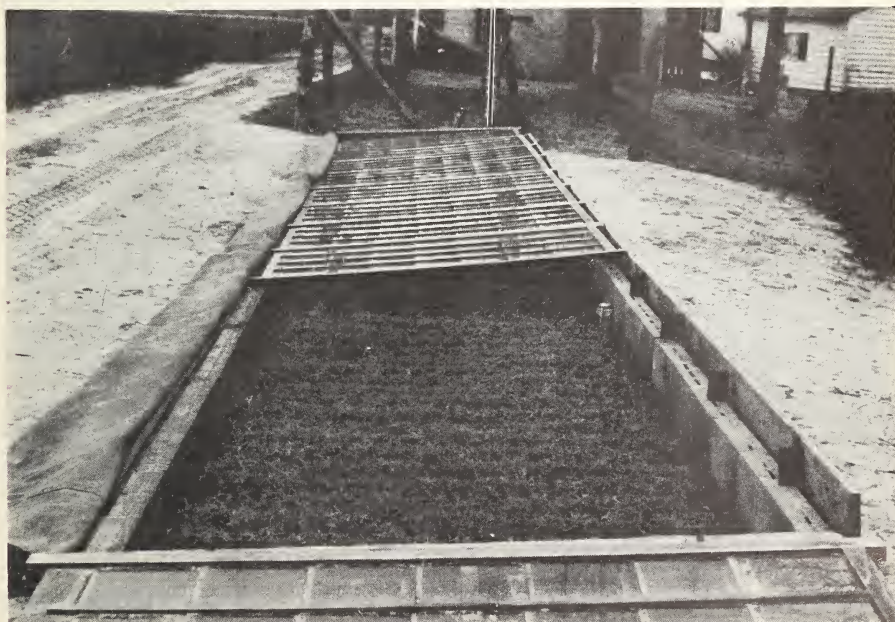
Operation

To control the temperature in the bed satisfactorily, the thermostat

must have an "open" and "close" range of not more than 5°. Check its operation as follows:

Set the temperature indicator at the maximum temperature desired for the bed. Place the thermostat bulb in water. Heat the water to the maximum temperature desired for the bed. Use a reliable thermometer to determine the water temperature. A pilot lamp operated by the thermostat is handy to indicate thermostat operation. The thermostat should open—shut off the current—when the set temperature is reached. This is indicated by the pilot light going out. (A slight clicking noise also indicates that the thermostat opened.) If the thermostat did not open at the desired temperature, adjust it until it does.

Allow the water to cool 5°. The thermostat should close—turn on the current. This is indicated by the pilot lamp lighting. If the thermostat did not close, make the necessary adjustment if possible, or replace it with another one.



Hotbed showing electric wiring.

OPERATING THE BED

Soil for Plants

Place a 4-inch layer of good soil in the bed. Use soil that is free of weed seeds and disease. In many instances it is desirable to sterilize the soil with heat or chemicals to kill any weed seeds and to reduce the possibility of disease.

Your county agricultural agent can give you information about sterilization of the soil. He can also help you with testing the soil to determine what fertilization is needed.

Plant Growth

Plants grow rather rapidly in electrically heated beds. Therefore, do not seed the beds too early.

A soil temperature of 70° to 75° F. is ideal for planting most seed. After the seeds germinate, adjust the temperature to suit the particular plant. Cool-season crops, such as cabbage, cauliflower, and lettuce, require an air temperature during the day of 60° to 65°. Warm-season crops, such as eggplant, peppers, tomatoes, and melons, require an air temperature of 65° to 75°. For satisfactory results, night air temperatures might be 5° to 10° lower than day air temperatures.

To insure that the proper soil and air temperatures are maintained, use two thermometers—one for checking soil temperature and another for checking air temperature above the plants. Place the soil thermometer at the same depth in the soil as the thermostat or remote bulb.

Air temperature in the bed should not go above 85° F. If the

temperature gets too high, ventilate the bed, but avoid exposing the plants to damage from wind, rain, or excessive cold. Some ventilation will probably be needed on all mild, sunny days.

Attention to watering is particularly important with electrically heated beds. Keep the bed moist at all times, but do not apply too much water. Apply water in the morning so that plant foliage will dry off before evening.

Conserving Heat

Good operating and maintenance practices conserve heat and reduce operating costs.

Be sure all joints are windtight. Keep soil banked around the outside of the walls. Replace broken or poorly fitting glass in glass sashes. Repair holes in glass-substitute material.

During extremely cold weather, cover sashes with straw or substitute material. This will protect plants and lower operating costs. But do not allow this additional covering to block out too much sunlight.

OPERATING COST

The cost of operating an electrically heated bed depends on the time of year, weather conditions, management, location, and construction.

Tests at various locations indicate that a 3-by-6-foot bed uses 1 to 2 kilowatt-hours of electricity per day.

Well-constructed beds cost less to operate than poorly constructed ones, and over a period of years the savings will pay for the additional building cost.

